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Art. VIII.—*On the Faunal Subregions of Australia.*

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(Communicated by J. A. Kershaw).

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"A considerable amount of ingenuity has been expended in trying to solve the interesting problem of the distribution of southern faunas. * * * * * No doubt our knowledge will increase, but it seems hardly possible to make any more theories."

The quotation above from Captain Hutton's erudite paper, "Theoretical Explanations of the Distribution of Southern Faunas," published in the Proceedings of the Linnean Society of New South Wales, 1896, epitomises the position of our present subject in its general bearings as left by Hutton. My intention is only to deal with the zoogeographic sub-regions and districts of the continent of Australia, and, for this purpose, it is only necessary to refer to two previous essays, viz., Professor R. Tate's address "On the Influence of Physiographic Changes in the Distribution of Life in Australia," published in the "Report of the Australasian Association for the Advancement of Science," 1888; and Professor W. Baldwin Spencer's "Summary of the Zoological, Botanical and Geological Results," embodied in the "Report on the Work of the Horn Scientific Expedition," 1896.

For zoologists Spencer's splendid summary is indispensable, while the ability shown in Tate's work makes it of first-class importance.

To make clear my point of view towards this much-discussed subject, and to establish a meeting-ground for my readers and myself, the following definitions of my position in regard to some fundamental tenets of zoogeography are offered.

1. Permanence of continents. Darwin's position was that the great continents had maintained approximately their present positions since early geological times. Wallace also held strongly the same view. But when we admit the union of Australia with an Antarctic continent, probably in the Miocene, the idea of any necessary permanence for the present continents beyond the middle of the Tertiary Era must be given up.

2. Length of time required for the distribution of any group of land animals. We must suppose that sufficient land bridges have occurred in the Tertiary Era to have enabled any group to have spread over the whole earth. The case of the struthious birds may be cited in support of this view, for this terrestrial group of the Tertiary Era, as is shown by its geological and present distribution, has found land connections which enabled it to send members into every faunal region of the globe.

3. Insects—including the order Coleoptera—are older than the angiospermous plants; therefore, any biological regions established for plants will likely also be suitable for insects.

4. Wallace's view that the great faunal regions should be founded on the mammalia ought to be adhered to.

5. Plants and insects of the order Coleoptera were in Australia in Pre-Cretaceous times, and have always been there since.

6. Parts of Australia—(e.g., ranges of south-west Australia, Mount Lofty and Flinders Ranges, MacDonnell Ranges, parts of Australian Alps)—have been dry land since the Palaeozoic Era.

7. Following Deane and Spencer, the idea of a cosmopolitan Tertiary flora which occupied Australia must be abandoned.

8. There are entomological reasons for supporting the existence of the Huxley-Hutton Mesozoic Trans-Pacific continent in warm latitudes.

9. The entry of the marsupials into Australia from an Antarctic source, as advocated by Hedley and Spencer, is to be accepted.

10. Tate's idea of a Post-Miocene extension of Australia to the southward, to account for some analogies which Kangaroo Island and Port Lincoln present with his Autochthonian Region, is a good one. It has some entomological support.

Hutton and Spencer have agreed in ascribing four separate elements to the fauna of Australia Tate, in his able exposition of the botanical geography of Australia, divided the flora into two primary parts. I shall quote his words :—

"The flora of Australia consists of the following constituent elements :—

I. An immigrant portion.

II. An endemic portion."

He then divided the immigrant portion into two parts in the following words :—

"(a) Oriental, which is dominant in the littoral tracts of tropical Australia. (b) Andean. For the most part this type of vegetation is restricted to the high mountains of Tasmania, Victoria and New South Wales."

In regard to the endemic portion, he says :—

"I will divide the Australian Endemic Flora into three types.

1. Euronotian, dominant in the south and east parts of the continent.

2. Autochthonian, restricted to the south-west corner of West Australia, and approximately coinciding with the rainfall limit of twenty inches.

3. Eremian, dominant in the dry region, which has its centre in the Lake Eyre Basin."

Towards the end of his address, he says briefly of the fauna—"Not only in the Eremian Region, but in the others, the fauna of each will exhibit, though perhaps in a less degree, similar relationships to one another as the floras."

Summing up with regard to the fauna of his Autochthonian and Eremian Provinces, his words are as follows :—

"The Autochthonian Province is without distinctive features other than specific.

The Eremian Province has many specific, and some generic peculiarities, but is essentially Australian."

In the year 1896 Spencer reviewed the question of faunal sub-regions for Australia in a masterly manner, and published a map showing the results he arrived at from a careful study of the distribution of the higher animals. In this map two of Tate's botanical regions are adopted, viz., the Euronotian and the Eremian; but, owing to Spencer's faunal sub-regions, in no case corresponding altogether with Tate's regions, new names are proposed for the three faunal sub-regions of Australia, viz., Torresian, Bassian and Eyrean sub-regions. The Torresian and Bassian sub-regions are together the same as Tate's Euronotian region, which is divided into two at the Clarence River; the Eyrean sub-region comprises Tate's Eremian and Autochthonian regions united together.

Spencer briefly sums up the elements found in the fauna of Australia. I shall quote his words :—

"The present fauna may therefore be regarded as consisting of some four elements which may be very briefly outlined as follows :—(1) An older one derived from a land connection with Asia, the constituents of which it is difficult to define, and which existed partly in the western and partly in the eastern division when these two were separated. * * * * * * (2) A series derived from a connection with a land area lying to the east of the continent (and connected also with the Papuan region) represented by Microphyura

and Acanthodrilus amongst lower forms and the struthious birds amongst vertebrata. (3) A series derived from the Austro-Malayan region. * * * * * * (4) A large and important series derived from the south and indicating a former connection with South America across Antarctic lands during a period not later than the Miocene."

With regard to the Pacific element, Mr. Hedley's views require attention. His paper, entitled "A Zoogeographic Scheme for the Mid-Pacific," published in the Proceedings of the Linnean Society of New South Wales, 1899, ends with the following sentences:— "No sign of an American immigration can be traced in the Central Pacific. Had the Trans-Pacific Jurassic Continent, advocated by such writers as Hutton and Baur, any foundation in fact, then, if not terrestrial, at any rate, marine forms should now extend eastwards from America along its former site." My view is that the close relationship between the Carabidae of Australia and New Caledonia (half the genera of the New Caledonian Carabidae are found in Australia), the presence in Australia of Cicindelidae belonging the genera Megacephala and Rhysopleura (the nearest relations of which are now found in South America), and, also, some evident relationships which exist between some of the Carabidae of Australia, New Zealand, and the Hawaiian Islands (the genus *Mecyclothorax* is found in these three lands) require the ancient Trans-Pacific continent for their explanation.

For the four elements found in the Australian fauna by Spencer and others I shall adopt the names *New Holland*, *Pacific*, *Antarctic* and *Austro-Malayan*. All these names except New Holland are in general use, but I have seen no satisfactory term for the element for which the name New Holland is now proposed. It is Tate's "endemic" element, and is perhaps not quite the same as Hutton's "Australasian" element. The term endemic is objectionable, for being an adjective in common use it cannot be given a restricted and technical meaning without causing confusion. It is not easy to choose such terms, and New Holland could perhaps be improved upon, but, at least, it is distinctive, and having become obsolete its assignment as a term to designate the primary element in the Australian fauna may be allowed, at any rate till a better name is proposed.

I shall now briefly review the Cicindelidae and Carabidae to see how the four elements of the Australian fauna appear in their case. It will be convenient to take the most recently arrived elements first,

because the more recent constituents are more readily discerned than those of older date.

1. *Cicindelidae.*—This family may be taken to be wholly an immigrant group, derived from the Austro-Malayan and Pacific sources. The genera *Cicindela* and *Tricondyla* are Austro-Malayan; *Megacephala*, *Nickerlea*, *Distypsidera* and *Rysopleura* are of Pacific origin.

2. *Carabidae.*—The Carabidae of Australia with Tasmania as at present known are comprised of 28 tribes, 200 genera and 1430 species; amongst this great complex are found representatives of the four elements of the Australian fauna, but it is not yet easy to define clearly the Pacific and Antarctic types from one another, nor either of these from the New Holland element.

(1) Austro-Malayan.—This element is very largely represented in the fauna of Australia, especially in the Cape York Peninsula. The following 10 tribes are wholly Austro-Malayan as far as their Australian representatives go :—Apotomini, Panagaeini, Chlaeniini, Masoreini, Perigonini, Odacanthini, Dryptini, Physocrotaphini, Zuphiini, Brachynini. These tribes contain 20 genera and 52 species. Only one of these genera, viz., *Eudalia*, belonging to the tribe Odacanthini, is peculiar to Australia. The percentages of the Australian totals shown by this immigrant fauna are :—Tribes 35.7, genera 10, species 3.6; and there are besides at least 25 genera belonging to cosmopolitan tribes which are of evident Austro-Malayan origin; the addition of these would make 45 Austro-Malayan genera in Australia or 22.5 per cent. of the total number. If we take away from the Australian total of 28 tribes the 10 Austro-Malayan tribes recognised above, it leaves Australia with a Carabfauna poor in tribal types. Europe had in 1896 34 tribes, 145 genera, and 2180 species.

(2) Antarctic.—There is one tribe in Australia of undoubted Antarctic origin, viz., Migadopini; it is confined to the Bassian subregion, and has representatives in New Zealand and South America (also in the Falkland and Auckland Islands). The Mecodemides (Genera *Percosoma*, *Lychnus*, etc.), a group of the tribe Broscini, largely represented in New Zealand, is also an Antarctic group.

(3) Pacific.—I have not been able to recognise satisfactorily the constituents of the Pacific element in the Australian Carab-fauna. Probably this can only be done by someone with a good knowledge in nature of the faunas of New Caledonia and New Zealand.

(4) New Holland.—Tribes Pamborini and Cuneipectini. Groups Carenides (tribe Scaritini) Promecoderides (tribe Broscini), the

Australian section of the tribe Helluonini, the Australian section of the tribe Pseudomorphini, etc. The Carabidae are not sufficiently carefully worked out and compared with those of other regions for any work of value to be done yet.

There is apparently no reason for entomologists to dissent from the adoption of Spencer's three faunal sub-regions; they seem to suit the Carabidae, though the order Coleoptera is so ancient that its distribution might have been expected to accord with that of the plants rather than with that of the mammalia. We will take a brief glance at these three faunal sub-regions, and the districts into which I divided them on entomological grounds in the year 1905.

The Torresian has the richest fauna of any of the sub-regions of Australia, and is largely stocked by Austro-Malayan types found nowhere else on the continent. It is a tropical and sub-tropical country with a variable climate, which in some places near the seaboard has a high average rainfall, and a tropical flora, such as accompanies a heavy rainfall where the soil is good; in other parts rather dry, and with open forests; its rivers are numerous, though, owing to there being no lofty mountains and the nearness of the watershed to the coast, no such great rivers as might have been expected are present. The Torresian and Eyrean sub-regions are now fused together, with the arid climate of the Eyrean subregion as the chief obstacle to the complete intermixture of their faunas. It is impossible to draw a definite line between these subregions, unless empirically, as was done by Tate when he adopted the line of twenty-five inches of mean rainfall as the boundary between his Euronotian and Eremian botanical regions. It is reasonable to expect that the hardy Eyrean fauna will have been able to encroach into the more favoured Torresian region to a greater extent than has the Torresian fauna into the Eyrean steppes, though the comparative freedom from competition in the sparsely inhabited Eyrean country may have been favourable to a widespread range for some hardy Torresian forms.

The districts proposed by me in the year 1905 for the division of the continental part of the Torresian sub-region were three, as under :—

(1) West Torresian District.—This was divided from the rest of the sub-region by a line drawn north and south from near the bottom of the Gulf of Carpentaria. The typical insect fauna of the West Torresian district will probably be found about the Daly River, but I know very little of the entomology of this district. The strange genus *Delinius* of the tribe Pterostichini is peculiar to the district.

(2) Middle Torresian District.—This extends from about the bottom of the Gulf of Carpentaria to near the tropic, having the Bellenden Kerr Mountains for its central feature. The genera *Steganomma* (tribe Scaritini), *Mecynognathus* and *Loxogenius* (tribe Pterostichini) are not found beyond the limits of this region; also *Rhysopleura*, a remarkable genus of the family Cicindelidae.

(3) South Torresian District.—This extends from the tropic to the Clarence River. Its typical Carabidae are found from the Burnett to the Richmond River. *Liopasa*, *Leirodira* and *Notolestus* are distinctive genera (tribe Pterostichini) belonging to this district.

The Bassian sub-region is a country of mountains, rivers and forests. In its past history we may imagine great ranges of mountains covered with perpetual snow, which presented a barrier to the southward progress of the fauna of the north; for this reason, we may suppose the Cicindelidae failed to reach Tasmania, or, except as very recent immigrants, Victoria south of the dividing Range; for the same reason such characteristic Australian groups of the Carabidae as the Carenums and Helluonini have not extended to Tasmania, and are hardly represented in Southern Victoria.

Through the continental part of the Bassian sub-region five reciprocal routes of past migration may be perceived; viz., three from north to south, and two from east to west. The north and south routes will be, one over and along the mountains, and a route on each side of the mountains available for the fauna of the lowlands. Such species as the Carenums *Laccoscaphus loculosus* and *L. foveipennis* may be taken as lowland forms, which spread into Victoria and the south-eastern parts of South Australia along the western lowland route. The two east and west routes will be, (a) Tate's Post-Miocene route across a former southward extension of Australia. This must have been a forest-clad land across which have passed such Carabidae as the ancestors of the present species belonging to the genera *Promecoderus*, *Amblytelus*, *Platylytron*, *Hormacrus*, and the single species of *Notonomus* found in Western Australia. (b) The route which became available on the union of the Bassian and Eyrean sub-regions, and which has been taken advantage of by both Bassian and Eyrean types.

In the scheme proposed by me the Bassian sub-region was divided like the Torresian into three districts, viz., a northern, middle and Tasmania. There is apparently no true line of demarcation between (4) the North Bassian district, which centres on Sydney, and (5) the Middle Bassian district, of which the Australian Alps are the great natural feature.

The Eyrean Sub-region.—This immense division has generally a hot, dry climate; in no part has it a winter that brings snow nor even (except near Cape Leeuwin) decided dampness. There is abundant evidence of the long-continued prevalence of these conditions, with the result that the now dominant types of the fauna are composed of comparatively few wide-ranging species; such species being often found in isolated colonies, sometimes at great distances from one another. Attention was drawn to this fact by Professors Tate and Spencer in the Report of the Horn Expedition. Some of the most distinctive wingless Carabidae of the Eyrean sub-region range from the coastal districts of Western Australia to New South Wales (such are *Carenum elegans*, *C. scaritioides*, *Neocarenum elongatum*, *Parroa howitti*).

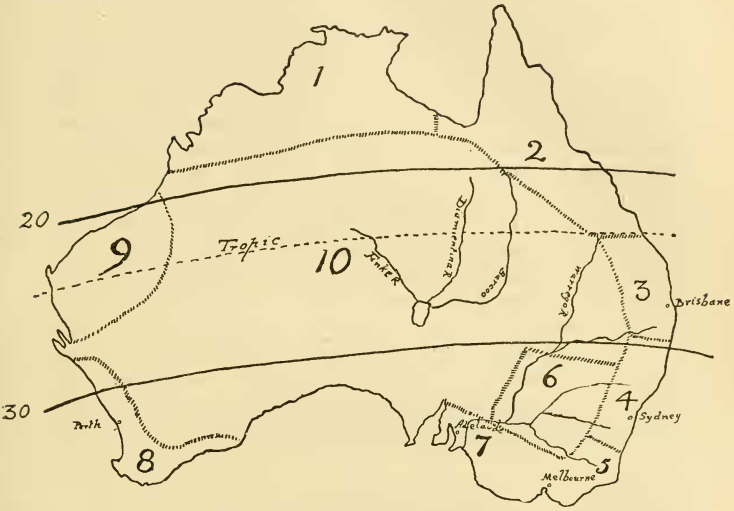
Doubtless there are several centres of distribution in the present Eyrean sub-region (e.g., Flinders Range, MacDonnell Ranges, ranges of South-western Australia). There has been a great deal of immigration into it from the Torresian and Bassian sub-regions. The Carabidae of the Eyrean sub-region are not numerous, considering its great area; the eastern parts have more genera and species than the western parts, owing to the numerous Torresian and Bassian forms which have invaded the eastern borders of the sub-region. Characteristic groups are:—The tribe Cuneipectini (one genus with two species), the group Carenides (tribe Scaritini), and such genera as *Gnathorys*, *Parroa* and *Adotela* (tribe Broscini), *Phorticosomus* (tribe Harpalini), *Helluarchus* and *Helluapterus* (tribe Helluonini).

I divided the Eyrean sub-region into five districts in 1905. These were numbered on my map from 6 to 10.

(6) The Riverina district is probably merely part of the eastern marches of the Eyrean sub-region. It may be considered to take in the whole of the basin of the River Darling, its western boundary being the watershed between the Darling and Barcoo Rivers. Its chief distinctive character is the prevalence of immigrant forms from the Bassian and Torresian sub-regions.

(7) The South Australian District.—This has for its centre the Mount Lofty and Flinders Ranges; probably it should include the Victorian Mallee districts, and it may extend round the head of Spencer's Gulf to take in Eyre's Peninsula. It has two very isolated genera of the tribe Pterostichini, viz., *Secatophus* and *Teropha*.

(8) South-west Australia.—This district should be defined by the rainfall line of twenty inches to correspond with Tate's Autochthonian Province.



Map showing entomological districts of Australia as now suggested.

1. West Torresian District 2. Middle „ „ 3. South „ „	Continental part of Torresian Subregion of Spencer.	Euronotian Province of Tate.
4. North Bassian „ 5. Middle „ „	Continental part of Bassian Subregion of Spencer.	
6. Riverina „ 7. South Australian „ 8. South West Australia 9. North West Australia 10. Central Australia	Eyrean Subregion of Spencer.	

6, 7, 9, 10 form Eremian Province of Tate, with rainfall less than 25 in.; 8 is Autochthonian Province of Tate.

(9) The North-west District.—This is perhaps a weakly defined portion of the Eyrean sub-region; probably all the country watered by the De Grey, Ashburton, Gascoigne and Murchison Rivers should be included in it, but its Carabidae are too little known, especially in regard to their eastward range, for this district to be treated of with confidence.

(10) Central Australia—as intended by me in 1905—corresponded to the Larapinta district of Tate (Horn Expedition, Botany), which centres round the MacDonnell Ranges, but in practice it may be

taken to comprise all that is left of Spencer's Eyrean sub-region after the other four districts treated of above are removed.

In conclusion, I wish to emphasise the view that such faunal districts are better suited than any political divisions for use by biologists to show the distribution of genera and species. Such districts can be employed to impart a greatly added value to published lists of species, without adding to their bulk (this being an important consideration in dealing with such an order as the Coleoptera, which requires a large volume for the mere enumeration of the names of its innumerable species). If a map be given with the districts numbered on it, these numbers can be added on the same line as a name of a species in the list without increasing its bulk or price. It is much to be desired that workers in different groups should use the same set of faunal districts, and it is not to be supposed that a system of districts which will commend itself generally to zoologists can be evolved without much study and research. At present I can only feel confident of Tate's Autochthonian Region being a surely defined faunal district.